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soon as possible to avoid greater loss, unless they can be stored in a dry place at temperatures between 32° and 40° F., which practically inhibit the growth of the fungi that are known to cause *Fusarium* tuber rot.

HOW CAN THE DISEASE BE CONTROLLED?

Since *Fusarium* tuber rot and *Fusarium* blight proceed from the soil, their control is a very difficult matter.

No one thing will control *Fusarium* blight. It is desirable that care be taken to avoid planting seed stock produced by blighted plants. Crop rotation and the practice of the best cultural methods known in order to increase the vigor and resistance of the plant to these soil fungi also are recommended. Finally, in the western sections the use of whole seed is recommended as a very effective means of reducing losses by blight.

No effective control measures are known for the control of those types of *Fusarium* tuber rot which are primarily field diseases. Crop rotation is recommended.

Since *Fusarium* tuber rot probably causes greater loss in the harvested crop than any other potato disease, its control is a very important matter. As already pointed out, some types of this rot can get started in the eyes, lenticels, and stolons, as well as through wounds, while others, such as "powdery dry-rot," can enter only through wounds. Careful handling during and following the digging of tubers, to avoid cuts and bruises, therefore, is very essential. Tubers should not be handled as if they were stones. They are living things, and their skin, even though very effective as a protective covering, is quite delicate and easily broken.

It is advisable to sort out diseased and frozen tubers before storing the crop. Such tubers are subject to *Fusarium* tuber rot and may act as centers of infection for others.

The storage and transit types of *Fusarium* tuber rot can be controlled by storing tubers in a dry place at temperatures between 34° and 40° F. It should be remembered, however, that some *Fusarium* fungi can grow at these temperatures and that tubers which are infected may appear sound upon removal from such storage condition and then rot rapidly when exposed to higher temperatures.

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COMMERCIAL CONTROL OF CITRUS SCAB

JOHN R. WINSTON
Pathologist



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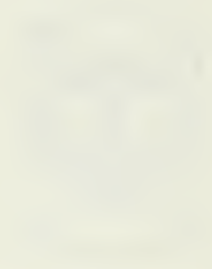
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COMMERCIAL CONTROL OF CITRUS SCAB.¹

IMPORTANT FACTS ABOUT CITRUS SCAB.

(1) Citrus scab is an imported disease of many citrus species. It occurs in India, China, Formosa, Japan, Hawaii, Paraguay, the Canal Zone, Yucatan, the West Indies, Canary Islands, South Africa, and in the citrus-growing regions of the Gulf States. As yet it has not become established in California or Arizona.

(2) This scab in Florida is second in importance to the melanose and stem-end rot caused by *Phomopsis citri*. It is the most serious fungous disease of the citrus nursery, where it attacks leaves and succulent twigs. In the orchard its activity is mainly confined to fruit and leaves.

(3) Leaves are most susceptible in the very early stages of growth. They become entirely resistant by the time they reach a width of one-half inch.

(4) Young grapefruits are extremely susceptible to infection immediately after the falling of petals. They become progressively resistant until they reach immunity at a diameter of about three-fourths of an inch.

(5) Scab infections are likely to occur whenever there is sufficient moisture at the time the parts are in a susceptible stage. Under such conditions infections developing in the hot, rainy summer months are as severe as those occurring during the cool weather of spring or fall.

(6) Citrus scab is caused by a definite fungus, usually but erroneously referred to as *Cladosporium citri* Masse. It has none of the characters of *Cladosporium* Link. It has been confused with a common saprophyte in citrus lesions.

(7) The causal fungus does not live over winter on mature fruit. It passes this period on affected leaves, which act as foci of infection the following spring.

(8) The citrus-scab fungus does not appear to be more virulent now than was the case a few years after its introduction into America,

¹ This circular contains practical directions for the commercial control of citrus scab with the summary of a manuscript entitled "Citrus Scab: Its Cause and Control," by John R. Winston. These directions are printed in advance of the issue of the proposed bulletin in order that they may reach the grower in time for use this season. The complete bulletin, giving an account of the researches and experimental data on which the directions for the control of this disease and this summary are based, will appear later.

nor are the various citrus varieties changing their former susceptibility.

(9) There is no material difference in the percentage or degree of infection that can reasonably be attributed to immunizing or sensitizing influences produced by the rootstock on the scion.

(10) Cumulative evidence, including spraying experiments and orchard observations, goes to show that citrus scab can be controlled satisfactorily and economically. Scab in the nursery can be controlled readily by occasional applications of effective sprays.

(11) Plain Bordeaux mixture as well as Bordeaux-oil emulsion is very effective against citrus scab, either in the nursery or in the orchard. Burgundy mixture is distinctly less effective than Bordeaux mixture, and ammoniacal copper-carbonate solution is much less so.

(12) Lime-sulphur solution is much less effective against this disease than is Bordeaux mixture. The other sulphur sprays are no more effective against citrus scab than is lime-sulphur solution.

(13) Spraying after the smallest fruits have attained a diameter of three-fourths of an inch has no effect on the control of scab.

DIRECTIONS FOR THE CONTROL OF THIS DISEASE.

While the actual control of citrus scab per se by means of sprays is not especially difficult if the spraying is done with thoroughness at the proper time and with effective materials, the commercial control of scab on grapefruit presents numerous factors for consideration, some of which are extremely important.

Perhaps the most important single factor in so far as the well-being of the tree is concerned is the "beneficial" or entomogenous fungi. So effective are these fungi in the control of certain insect pests that there are numerous orchards which bear plentiful crops of excellent fruit without the aid of sprays. There are about 12 recognized species of entomogenous fungi in Florida citrus orchards. The earliest forms begin growth about the first of May, and the later forms are active until late fall or winter.

It is true that the time for spraying against scab on grapefruit usually has passed before the entomogenous fungi become active. It is also true that any fungicide especially effective in scab control is likely to persist on the sprayed parts for a considerable time after the period of scab infection has passed. Further, any fungicide effective against scab is likely to be very harmful to the entomogenous fungi. Therefore when an effective lasting spray is applied to control the scab fungus a corresponding control of entomogenous fungi is most likely to occur, and this would result in an enormous increase of insect pests unless drastic measures are taken to check them.

These entomogenous fungi seem to thrive best under local conditions which are especially favorable for citrus scab; for example, in those rather moist localities where natural control of insect pests is most pronounced attacks from citrus scab are usually severe.

Citrus scab tends to vary greatly in prevalence from year to year and section to section. Even in a given locality it varies a great deal, and the fact that an orchard is infected seriously with citrus scab is by no means strong evidence that the same property will be even lightly infected the following year.

Nevertheless, there are localities where citrus scab is regularly serious, others where the disease is usually moderately prevalent, and still others which are attacked only during years especially favorable for citrus-scab development. For the sake of economy these three types of localities should not adopt the same spray schedule for the control of citrus scab. A spray program which would list the least number of applications necessary to produce clean fruit in localities where citrus scab is constantly serious would be unnecessarily expensive in time consumed and materials used where the disease occurs only during years especially favorable for scab development.

On the other hand, one or two applications of lime-sulphur solution, though it is a weak, short-lived fungicide, made during the scab season is money well invested even if scab does not occur, for the reason that such applications practically eliminate red spiders and greatly reduce rust-mite injury.

The judicious selection of the spray material for use in a citrus orchard is by no means an easy task, because all sprays are not equally effective against scab, and certain of them are likely to be followed by injurious or even disastrous effects from later insect attack.

Bordeaux mixture is the most effective spray against scab, and when made up with lake or shallow-well (soft) water no spray injury should be expected. Usually deep-well (hard) water is satisfactory, but a few instances are on record where a moderate amount of spray burn has resulted from Bordeaux mixture being made with such water and applied on citrus trees. Unless extra applications of insecticides are made, scale insects are very likely to increase rapidly and do great damage following this spray.

Commercial Bordeaux preparations when used in sufficient quantity to give about three-sixteenths of 1 per cent copper in the diluted spray are effective though expensive substitutes for homemade Bordeaux mixture.

Bordeaux-oil emulsion is equally as effective against citrus scab as is plain Bordeaux mixture and as effective against insects as is oil emulsion of the same strength when applied separately. The

fungicidal effects outlast the insecticidal effects, and for this reason the usual treatment and sometimes extra applications for scale are required following the use of Bordeaux-oil emulsion.

Burgundy mixture is quite effective against citrus scab, but unless carefully made is likely to cause some injury to fruit or foliage. This spray is considered too dangerous for general use. Scale insects become very numerous following applications of this material.

Ammoniacal copper-carbonate solution is much less effective against citrus scab than is Bordeaux mixture. In general, it is not a desirable spray for scab control. Scale insects increase considerably following its use.

Lime-sulphur solution 32° Baumé, diluted 1 to 40, is not more than 50 per cent effective against severe scab infection, but for other reasons it can be applied profitably in many orchards. No spray injury has been observed where this material was used during the spring for scab control. This spray kills red spiders, rust mites, and scale crawlers.

Dry lime-sulphur and barium-sulphur when used on the basis of sulphur equivalents of standard lime-sulphur solution seem to be fairly satisfactory but quite expensive substitutes for the commercial lime-sulphur solution.

Soda-sulphur or sodium-sulphur compounds are expensive and comparatively ineffective substitutes for lime-sulphur solution for use against citrus scab. The hazard of spray burn is especially great following the use of sodium-sulphur compounds at fungicidal strengths.

The following spray schedules are drawn up to meet the varying degrees of citrus scab outbreaks as they occur in Florida orchards. Spray schedule No. 1 should be followed where scab is usually present in serious proportions; spray schedule No. 2 should be used in localities where citrus scab varies in prevalence from serious to moderate; spray schedule No. 3 is recommended for localities where citrus scab is a minor disease. This last schedule, because of its effect upon red spiders, mites, and insects, will prove profitable even if citrus scab does not occur on unsprayed trees.

Spray Schedule No. 1.¹

[For orchards where citrus scab is always serious.]

Application.	Date.	Materials used.	Object.
First application....	Just before growth sets in.	3-3-50 Bordeaux mixture plus 1 per cent oil. ²	To cover old scab lesions. Direct spray especially toward under-surface of leaves. Reduces very early citrus-scab infections.
Second application..	In height of bloom....	3-3-50 Bordeaux mixture plus $\frac{1}{2}$ per cent oil.	For protection of expanding leaves and small fruit against citrus scab.
Third application...	Two weeks later.....do.....	For protection of small fruit against scab.
Fourth application..	Two weeks after third application.	3-3-50 Bordeaux mixture plus 1 per cent oil.	Advisable if season is rainy for protection against scab. Will also reduce early melanose infection.

¹ Insecticidal applications must follow, to prevent serious scale injury.² Prepare 3-3-50 Bordeaux mixture in the usual way. Three quarts of oil emulsion, Government formula, in 50 gallons of Bordeaux mixture gives 1 per cent oil. Add the oil emulsion to the Bordeaux mixture while the latter is being thoroughly agitated in the spray tank. Keep up the agitation while spraying.

Preparation of boiled oil emulsion, Government formula.

[See U. S. Dept. of Agr. Farmers' Bulletin 933.]

Paraffin oil.....	gallons..	2
Water.....	gallon..	1
Fish-oil soap.....	pounds..	2

Put oil, water, and soap into a kettle or other vessel that will stand fire, and heat to the boiling point. While still very hot but after removal from the fire, pump the material into another vessel with a bucket pump and then pump back again.

To insure bright, clean fruit at harvest time follow this schedule with the regular scale, white-fly, and rust-mite spray applications (see Farmers' Bulletin 933) and one or two additional applications to check the heavy increase of insect pests following copper sprays.

Spray Schedule No. 2.

[For orchards where citrus scab varies from moderate to serious.]

Application.	Date.	Materials used.	Object.
First application....	Just before growth sets in.	3-3-50 Bordeaux mixture plus 1 per cent oil.	To cover old scab lesions; direct spray especially toward under-surface of leaves; reduces very early citrus-scab infections.
Second application..	In height of bloom....	Lime-sulphur, 1 to 40 or 3-3-50 Bordeaux mixture plus $\frac{1}{2}$ per cent oil.	If season is normal use lime-sulphur; if season is rainy use Bordeaux mixture, to protect expanding leaves and small fruit from citrus scab.
Third application...	Two weeks later.....do.....	If season is normal use lime-sulphur; if season is rainy use Bordeaux mixture, to protect small fruit from citrus scab.
Fourth application..do.....	3-3-50 Bordeaux mixture plus 1 per cent oil.	If season is rainy probably advisable for protection of smallest fruits against citrus scab; will also reduce early melanose infection.

To insure clean, bright fruit at harvest time follow this schedule by the regular scale, white-fly, and rust-mite spray application. When Bordeaux mixture is used additional applications of oil emulsion most likely will be necessary.

Spray Schedule No. 3.

[For orchards where citrus scab is of minor importance.]

Application.	Date.	Materials used.	Object.
First application....	Just before growth sets in.	Lime-sulphur, 1 to 30..	To cover old scab lesions, direct spray especially toward under-surface of leaves; prevents early scab infections.
Second application..	In height of bloom....	Lime-sulphur, 1 to 40..	To prevent infections on expanding leaves and small fruit.
Third application...	Two weeks later.....do.....	To prevent infections on expanding leaves and small fruit. (Advisable only if season is especially favorable for scab development.)

To insure clean, bright fruit at harvest time follow this schedule by the regular scale, white-fly, and rust-mite spray applications.

Nurseries can be kept commercially free from citrus scab by occasional applications of Bordeaux-oil emulsion. As a rule, monthly applications probably will afford adequate protection. In many instances a smaller number of applications will suffice; however, the frequency of application is dependent upon local and seasonal conditions. Care must be taken to keep new flushes protected during periods of wet weather.

The use of Bordeaux-oil emulsion has been followed by a considerable increase in the growth of grapefruit seedlings even when citrus scab did not occur in the planting. Where citrus scab has occurred in sour-orange and rough-lemon seedlings the increase of growth following applications of Bordeaux-oil emulsion has been greater than the probable retardation due to scab. These two observations seem to indicate that this spray mixture may act as a growth stimulus in citrus nurseries.



